Unit 3

Components Value Identification

Introduction

Circuit designing and assembling is an interesting, innovative and responsible job. A large number of electrical and electronic components are available in market. For a beginner, it is difficult to identify these components. To get an idea about the components, we have to search for data sheets and books. This Unit will guide students to select the appropriate components. They will also learn to calculate the component value by reading a code mentioned on the component.

Component selection is a process of selecting a suitable component or a set of similar components from different suppliers for a designed circuit so that it performs its intended operation. A component engineer may have to first understand the circuit functionality or get the exact component with permissible tolerance. Most of the time, the design engineer invariably provides a list of critical parameters alone. But for the component engineer, the other non-listed parameters are also important. Therefore, it is important that the component engineer asks questions to the design team even for the smallest of doubts.

NOTES

Only choosing the right component is not sufficient for product development but tracking and controlling every component's specifications throughout the supply chain and the product's life cycle is also significant. The life cycle of the component is yet another attribute that should be focussed upon while selecting a component. It is more relevant in case of semiconductor IC chips. The predicted life of the components inside the product constitutes to the life of the product itself in addition to other variables. The present 'availability' factor of the component is important but for how long is the component going to be available in future is more important. When replacing the components, there are unpredictable risks. Hence, one must always maintain a list of alternate components and sources.

The next important aspect to consider is the 'reliability' of the component, which is termed as the capacity of the component to perform its planned function for the specified time under defined environmental conditions.

Identification of resistor

Resistors are the fundamental components of electrical and electronics industry. A resistor opposes the flow of current in a circuit. The amount of opposition is measured in Ohm. The Ohmic value is mostly printed on the resistor in the form of a code. In a surface mount resistor, the Ohmic value is printed on the surface, whereas, in a carbon film resistor, it is printed in the form of bands of colour code. Learning the codes and by using a helpful mnemonic device, one can identify the value of resistors easily.

There are two methods for manually reading and identifying the value of a resistor. These are

1. Colour coded resistors (Axial resistors)
2. Alphanumerically coded resistors (surface mount resistors)

Colour coded resistors (axial resistors)

Axial resistors are cylindrical in shape with leads extending at each end. They are colour coded. The basic shape of an axial resistor is shown in Fig. 3.1(a). An axial resistor in colour coded form with four or five bands is shown in Fig. 3.1(b).

In case of a four-band resistor [Fig. 3.1(b)], the first two bands represent the significant digit, the third represents a multiplier and the fourth represents the tolerance. In case of a five-band resistor, the first three bands represent significant digits, the fourth represents a multiplier and the fifth represents the tolerance.

Resistors are colour coded mainly because of the difficulties in writing a value on the side of the resistor and the many errors that would occur.

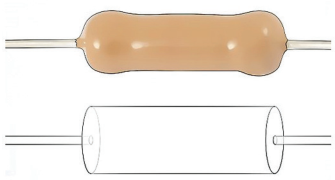


Fig. 3.1(a) Basic structure of an axial resistor

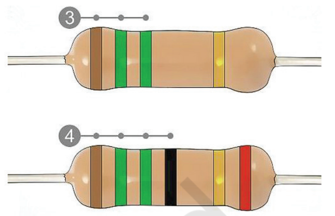


Fig. 3.1(b) Colour coded axial resistor

Colour	Number
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

Fig. 3.1(c) Colour code

Specifications of four-band resistor

- The resistor is read this way—with the three colour bands on the left of the resistor and the single band to the right.
- The first band on a resistor is interpreted as the first number of the resistor value. For the resistor shown below, the first band is yellow, so the first number is 4 (Figs. 3.2 and 3.3).

Fig. 3.2 Four-band resistor

Fig. 3.3 Four-band resistor specification

- The second band is the second number. This is a violet band, making the second digit 7.
- The third band is called the multiplier and represents the number of zeros. In this case, it is orange, which is 3.

- So the value of the resistor is 47000Ω or 47kΩ.
- The fourth colour represents the tolerance.
- Tolerance gives an upper and lower value that the resistor must be in. Take the following example for a 100Ω resistor.

Table 3.1 Tolerance value

Tolerance	Colour	Stated	Allowed upper value	Allowed lower value
+/-1%	Brown	100 Ω	101 Ω	99 Ω
+/-2%	Red	100 Ω	102 Ω	98 Ω
+/-5%	Gold	100 Ω	105 Ω	95 Ω
+/-10%	Silver	100 Ω	50 Ω	90 Ω

Colour	Significant figures			multiplier
Black	0	0	0	1Ω
Brown	1	1	1	10Ω
Red	2	2	2	100Ω
Orange	3	3	3	1KΩ
Yellow	4	4	4	10KΩ
Green	5	5	5	100KΩ
Blue	6	6	6	1MΩ
Violet	7	7	7	10MΩ
Grey	8	8	8	
White	9	9	9	
Gold				
Silver				

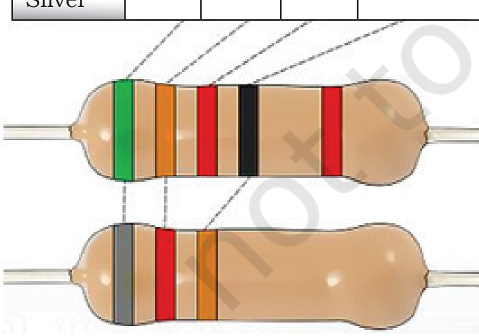


Fig. 3.4 Colour coding chart of a resistor

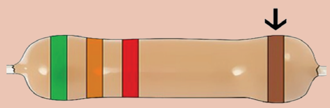
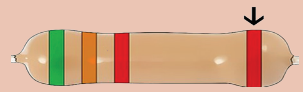
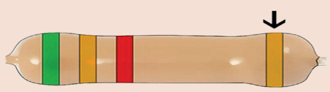
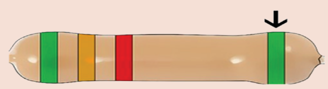
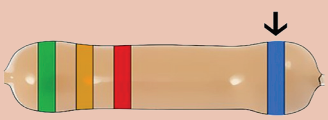
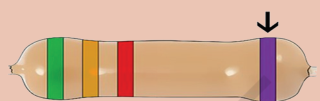
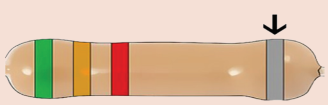
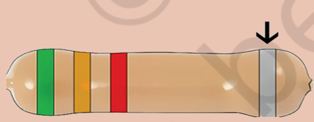
Calculation of resistor value

Read the colour bands from left to right. The colours on the first two or three bands correspond to numbers from 0 to 9, which represent the significant digits of the resistor's Ohmic value, the last band gives the multiplier (as shown in Fig. 3.4). For example, a four-band resistor with brown, brown, yellow and gold bands is rated at 11×10^4 or 110 kilo-Ohm with 0.1 tolerance. The code is as follows.

Brown: 1 significant digit
Brown: 1 significant digit
Yellow: Multiplier of 10^4
Gold: Tolerance of 1/10
Silver: Tolerance of 1/100

The last colour band represents the tolerance value of a resistor. To calculate the tolerance value of a resistor, read the colour on the last colour band, which is to the farthest right. This represents the tolerance of the resistor. If there is no colour band, the tolerance is 20 per cent. Some of the resistors have no, silver or gold band. In such cases, the tolerance band is of some other colour. The tolerance value for an axial resistor is given in Table 3.2.

Table 3.2: Tolerance value and colour of tolerance band

Brown: 1% tolerance  *Fig. a*	Red: 2% tolerance  *Fig. b*
Orange: 3% tolerance  *Fig. c*	Green: 0.5% tolerance  *Fig. d*
Blue: 0.25% tolerance  *Fig. e*	Violet: 0.1% tolerance  *Fig. f*
Grey: 0.05% tolerance  *Fig. g*	Gold: 5% tolerance  *Fig. h*
Silver: 10% tolerance  *Fig. i*	

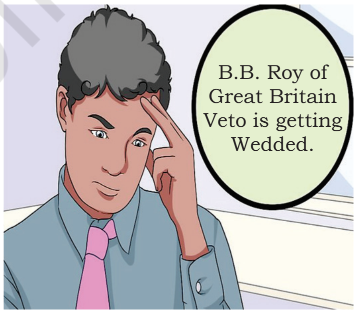


Fig. 3.5 Memorising colour codes

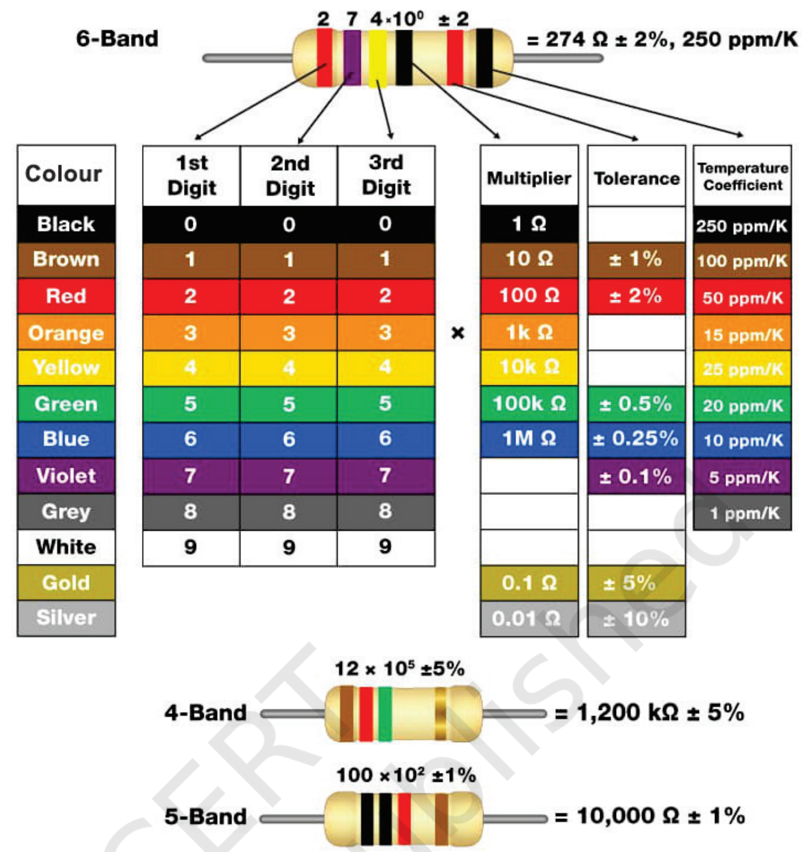
Colour	
Black	B
Brown	B
Red	R
Orange	O
Yellow	Y
Green	G
Blue	B
Violet	V
Grey	G
White	W

Fig. 3.6 Colour codes

As one needs to memorise the colour code for resistors, it is important to choose a way so that it is not forgotten easily (Fig. 3.5). Remember that the first colour is black and so on. Each colour corresponds to a code in order from 0 to 9.

Some popular ways to memorise the sequence of colour code is as follows.

"**B. B. ROY** of **G**reat **B**ritain has a **V**ery **G**ood **W**ife".



Colour	1st Digit	2nd Digit	3rd Digit	Multiplier	Tolerance	Temperature Coefficient
Black	0	0	0	1 Ω		250 ppm/K
Brown	1	1	1	10 Ω	± 1%	100 ppm/K
Red	2	2	2	100 Ω	± 2%	50 ppm/K
Orange	3	3	3	1k Ω		15 ppm/K
Yellow	4	4	4	10k Ω		25 ppm/K
Green	5	5	5	100k Ω	± 0.5%	20 ppm/K
Blue	6	6	6	1M Ω	± 0.25%	10 ppm/K
Violet	7	7	7		± 0.1%	5 ppm/K
Grey	8	8	8			1 ppm/K
White	9	9	9			
Gold				0.1 Ω	± 5%	
Silver				0.01 Ω	± 10%	

Fig. 3.7 How to read resistor colour codes

Alphanumerically coded resistors (surface mount resistors)

1.	Surface mount resistors are rectangular in shape. Surface mount resistors have emanating leads. These leads are used for mounting resistors on the PCB. Some surface mount resistors use plates on the bottom side.	
2.	The first two or three numbers printed on the surface mount resistor represents significant digits and the last digit represents the number of zero that should follow. For example, a resistor reading 1252 indicates a value 125200 Ohm. For tolerance value, use the letter at the end of the code.	

3.	Compare the letter at the end of the code with the tolerance it represents.	
4.	A: 0.05% tolerance	
5.	B: 0.1% tolerance	
6.	C: 0.25% tolerance	
7.	D: 0.5% tolerance	
8.	F: 1% tolerance	
9.	G: 2% tolerance	
10.	J: 5% tolerance	
11.	K: 10% tolerance	
12.	M: 20% tolerance	
13.	Check to see if there is a letter 'R' within the numeric code. This indicates a very small resistor, and the letter takes the place of a decimal point. For instance, a 5R5 resistor is rated at 5.5 Ohm.	

Notes

Assignment 1

Taking Fig. 1 as reference, find the resistance value of the following colour code.

1. Red-brown-green-silver
2. Black-brown-red-orange
3. Brown-orange-red-gold

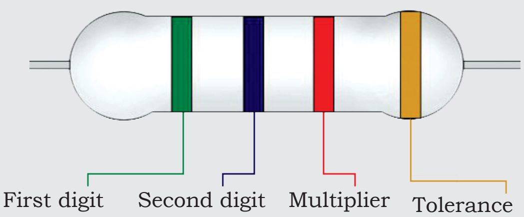


Fig. 1

Identification of capacitor

Reading a capacitor

Capacitor uses a wide variety of codes to describe its characteristics (Fig. 3.8). It is difficult to read the value of a small capacitor as it is printed in very small font size. For many low-voltage circuits, it is important to know the capacitance value and voltage rating of the capacitor. Capacitance is measured in Farad (F).

Measuring unit of capacitor

Capacitor values are, usually, tiny. To express those small values of capacitance, the metric system used is given below.

1 mF = 1 millifarad = 10–3 farad

1 µF = 1 microfarad = 10–6 farad

1 nF = 1 nanofarad = 10–9 farad

1 pF or µµF = 1 picofarad = 1 micromicrofarad = 10–12 farad

In general, millifarad and microfarad is used to measure the capacitance of household appliances.

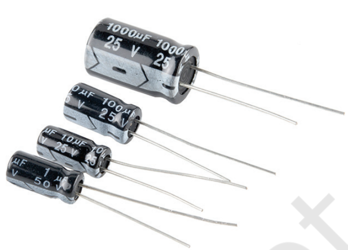


Fig. 3.8 Outer body of a capacitor

Reading capacitor value

It is important to read the capacitor values correctly. There will be some variation in the printing of the capacitance value. So, always look for the closely matched value of capacitance.

For example, the capacitor value printed in Mu may be treated as (µ) because the symbol for micro is difficult to typeset.

Sometimes the letter 'm' is used instead, resulting in micro-Farad being abbreviated as 'mF'. Technically, there is also 'milli-Farad'. But in practice, milli-Farad is almost never seen, with thousands of micro-Farad being more common.

For example, 'MF' is just a variation on 'mf'.

Abbreviation for farad is 'fd'. For example, 'mf' or 'mfd' is the same.

Single letter markings, such as '475m' are, usually, found on smaller capacitors for instructions. It represents the 475 milli farad.

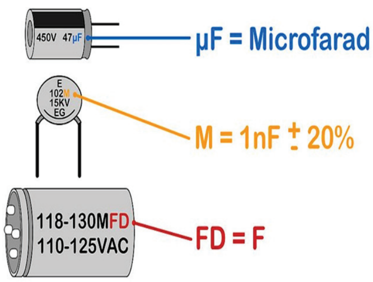


Fig. 3.9 Specification of a capacitor

Tolerance value of capacitor

Tolerance value of a capacitor is the maximum acceptable range of capacitance till the capacitor can work without damage. It is required to pay attention for a precise capacitor value. For example, a capacitor labelled '6000uF + 50%/-70%' could actually have a capacitance as high as 6000uF + (6000 × 0.5) = 9000uF, or as low as 6000 uF - (6000uF × 0.7) = 1800uF.

If tolerance percentage is not given, it can be calculated by using the alphabetic code printed on the capacitor (Fig. 3.10).

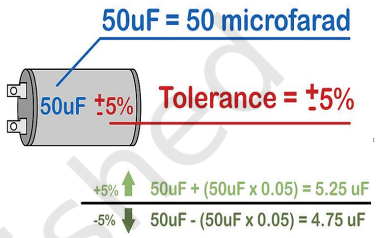


Fig. 3.10 Tolerance value of a capacitor

Voltage rating of capacitor

As the size of a capacitor is small, voltage is written as V, dc voltage rating as VDC, DC working voltage as VDCW and working voltage as wv. This is the maximum voltage of a capacitor (Fig. 3.11).

1 kV = 1,000 volt

If a capacitor is labelled with a single letter, such as V it can be assumed that it can work for both AC and DC voltage.

For example, to build an AC circuit, choose the capacitor rated specifically for VAC. The DC capacitor can only be used after converting it to AC.

A capacitor indicated with a minus (–) sign is an electrolytic capacitor. Such a capacitor is polarised. In such cases, make sure that the positive end of the capacitor is connected with the positive side of the circuit (Fig. 3.12). Otherwise, the capacitor may eventually cause a short circuit or even explode. The capacitor without + or – can be fixed in either way.

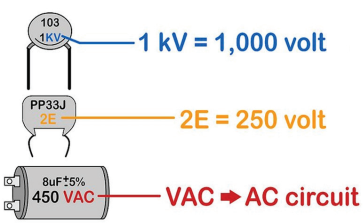


Fig. 3.11 Voltage rating of a capacitor

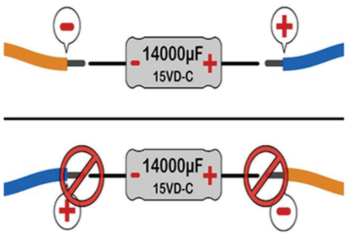


Fig. 3.12 Polarity of a capacitor

Fig. 3.13 Aluminium electrolytic capacitor

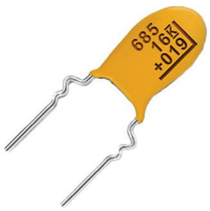
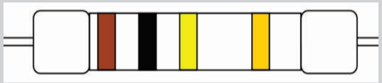
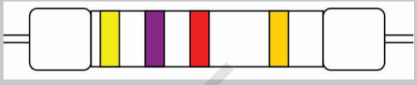
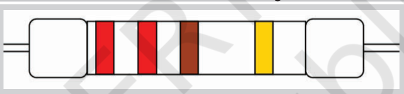
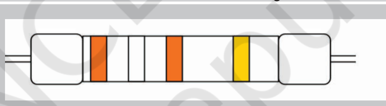


Fig. 3.14 Tantalum electrolytic capacitor

Some capacitors use a coloured bar or ring-shaped depression to show polarity. Traditionally, this mark designates the –ve end on an aluminium electrolytic capacitor as shown in Fig. 3.13. On tantalum electrolytic capacitors (which are very small) as shown in Fig. 3.14, this mark designates the +ve end.

Assignment 2

Analyse and write down the value of the resistors given below

Resistor	Value
 Brown-black-yellow-yellow	
 Yellow-violet-red-yellow	
 Red-red-brown-yellow	
 Orange-white-orange-yellow	
 Green-blue-red-yellow	

Check Your Progress

A. Multiple choice questions

1. What are the two major categories of resistors?
   (a) Low and high power value
   (b) Commercial and industrial
   (c) Low and high Ohmic value
   (d) Fixed and variable
2. What is the Ohmic value for the colour code of orange, orange, orange?
   (a) 22 kilo Ohm
   (b) 33 kilo Ohm
   (c) 3300 Ohm
   (d) 44000 Ohm

3. Which of the following is true for resistance?
   (a) Symbolised by R, measured in Ohm and directly proportional to conductance
   (b) Represented by the flow of fluid in the fluid circuit
   (c) Directly proportional to current and voltage
   (d) The opposition to current flow accompanied by the dissipation of heat
4. Resistor tolerance is either printed on the component, or provided by __________________.
   (a) company
   (b) keyed containers
   (c) colour code
   (d) size
5. For a fixed voltage, if resistance decreases, then the current will __________________.
   (a) decrease
   (b) double
   (c) increase
   (d) remain the same
6. Resistance in a circuit is __________________.
   (a) the same as current
   (b) in opposition to current
   (c) the same as voltage
   (d) in opposition to voltage
7. A colour code of brown, brown, red, gold is for which Ohmic value?
   (a) 1.2k Ohm 5%
   (b) 1.1k Ohm 5%
   (c) 1.3k Ohm 5%
   (d) 1.5k Ohm 5%
8. A colour code of black, brown, green, gold is for which Ohmic value?
   (a) 1×10^5 5%
   (b) 1×10^4 5%
   (c) 1×10^5 10%
   (d) 1×10^4 10%
9. A colour code of brown, red, orange, silver is for which Ohmic value?
   (a) 12×10^3 10%
   (b) 21×10^3 10%
   (c) 14×10^3 5%
   (d) 12×10^2 5%
10. A colour code of red, yellow, grey, gold is for which Ohmic value?
   (a) 23×10^8 5%
   (b) 24×10^8 5%
   (c) 25×10^7 5%
   (d) 22×10^7 5%

Notes